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Listeriosis Phytotherapy: A Review Study on the Effectiveness of Iranian Medicinal Plants in Treatment of Listeriosis

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Abstract

Listeria monocytogenes can be found in many processed foods, raw milk, dairy products, meat and meat products such as sausages, beef and fish products, seafoods, eggs, fruits, and vegetables such as radish and cabbage. This article is a review study on the Iranian medicinal plants applied for treatment of listeriosis. Information of this review article was obtained by searching various key words such as *Listeria monocytogenes*, medicinal plants, plant extracts and essential oils among scientific articles published in databases of Google scholar, ISI Web of Knowledge, PubMed, Scopus, SID and Magiran. Thyme, German chamomile, great chamomile, yarrow, onion, oregano, nutmeg, sage, sagebrush, hyssop, rosemary, St John's wort, safflower, ajowan, cumin, peppermint, shallot, anise, and parsnip are known antilisteriosis medicinal plants. Bioactive phytochemicals, antioxidants and monoterpenes, sesquiterpene, coumarin, flavonoids, tannins, saponins, alkaloids, and terpenoids are the main ingredients of antilisteriosis medicinal plants.

Keywords

Listeria monocytogenes, medicinal plants, Iran

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Listeria monocytogenes is a rod-shaped, Gram-positive, catalase-positive, oxidase-negative, and facultative anaerobic bacterium. Infections caused by this bacterium occur after consumption of contaminated water and food, and its symptoms are similar to flu, septicemia, and meningitis, especially in infants, pregnant women, the elderly, and immunocompromised individuals.[1]

Listeria monocytogenes can be found in many processed foods, raw milk, dairy products, meat, and meat products such as sausages, beef and fish products, seafood, eggs, and in fruits and vegetables, such as radish, cabbage, and so on.[2]

Listeria monocytogenes grows in fish oil, smoked salmon, crab meat, cooked shrimp kept at −4°C, and canned lobster meat kept at 10°C.[3] Food transmission is usually the main cause of sporadic and epidemic listeriosis in human. Recently, high rate of mortality and deaths of about 400 people in the United States due to listeriosis has become a matter of concern for food industries and regulatory organizations.[4]

Antimicrobial agents are chemical or natural compounds that are able to destroy or inhibit the growth of microscopic organisms.[5] Several agents with animal, plant, or microbial sources play important protective role against microorganisms. The most important antimicrobial activity of compounds can be attributed to the antimicrobial enzymes (lactoperoxidase, lactoferrin), antimicrobial peptides (natural phenols), catechin hydroquinone, esters of fatty acids, phenolic antioxidants, antibiotics, and metals (Cu).[6,7] Medicinal plants play important roles in the treatment and prevention of diseases and improvement of population health in the communities.[8-12] Public interest in the use of herbal-based medications and natural products have been increasing especially in the recent years.[13-16] Main reasons for this general approach are more side effects of chemical drugs and the environmental pollutions that threaten the earth.

Medicinal herbs as the effective and inexpensive sources of different drugs are used for the treatment and prevention of a wide variety of diseases, such as diabetes,[17-19] liver

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Table 1. List of Native Iranian Medicinal Plants Against *Listeria monocytogenes*.

No.	Scientific Name	Family Name	Common Name	Result
1	*Zataria multiflora* Boiss	Lamiaceae	Thyme	Thymus vulgaris has antimicrobial effects on *Listeria monocytogenes* alone with MIC and MBC, 9.5 and 19 μg/mL, respectively. Combination of essential oil and nisin reduced the amount of MIC and MBC to 1.2 and 2.4 μg/mL, respectively.[47]
2	*Zataria multiflora* Boiss	Lamiaceae	Thyme	Nisin at both concentration of 500 and 1000 IU/g could not reduce *Listeria monocytogenes* count (*Listeria monocytogenes* PTCC 1163) to below the permissible limit for healthy people. Inhibitory activity of nisin against the growth of *Listeria monocytogenes* was reduced with time. While a combination of nisin and thyme oil at a concentration of 0.8% and 1.2% decreased number of bacteria below the permissible limit during 12 days.[48]
3	*Matricaria chamomilla* L *Tanacetum parthenium* L	Asteraceae Asteraceae	German chamomile Great chamomile	MIC of German chamomile and great chamomile oils obtained in the range of 0.22-4 and 0.09-1 mg/mL, respectively. Differential inhibitory index of these plants essential oils demonstrated synergistic activity against *Listeria monocytogenes*, *Bacillus subtilis*, and *Bacillus cereus* and increased activity against *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella typhimurium*.[49]
4	*Achillea eriophora* DC	Compositae	Yarrow	Yarrows essential oil MIC against Gram-positive bacteria was 0.15-0.75 mg/mL and 1.5-3 mg/mL against Gram-negative bacteria, respectively. MIC against *Listeria monocytogenes* was 0.75 mg/mL.[50]
5	*Allium cepa* L.	Alliaceae	Onion	MIC for onion essential oil against *Listeria monocytogenes* was 125 μg/mL.[51]
6	*Origanum vulgare* *Myristica fragrans*	Labiatae Myristicaceae	Oregano Nutmeg	Results showed that antibacterial activity of oregano (with maximum and minimum growth inhibitory concentration = 0.62 μL/mL) was more effective than nutmeg (with minimal growth inhibitory concentration = 1.25 μL/mL and maximum growth inhibitory concentration = 2.5 μL/mL).[52]
7	*Artemisia aucheri* *Artemisia sieberi* *Hyssopus officinalis* L	Asteraceae Asteraceae Lamiaceae	Sage Sagebrush Hyssop	MIC of aqueous extract of sage and sagebrush against *Listeria monocytogenes* was 80 mg/mL.[53]
8	*Rosmarinus officinalis* *Hypericum perforatum* *Carthamus tinctorius*	Lamiaceae Hypericaceae Asteraceae	Rosemary St John's wort (Hardhay) Safflower	The pants has been shown to be effective against bacteria in various doses and it had anti listeriosisn in In-Vitro condition[54]
9	*Carum copticum*	Umbelliferae	Ajowan	Ajowan essential oil has showed bacteriostatic effect at 0.15% and bactericidal effect at 0.3% concentration against *Listeria monocytogenes* in white fish extract. Adding 4% salt to white fish extract increased antibacterial activity of ajowan essential oil significantly. Growth of *Listeria monocytogenes* in the white fish extract reduced significantly in these concentrations (0.15% and 0.3%) compared with control.[55]
10	*Cuminum cyminum*	Apiaceae	Cumin	Count of *Listeria monocytogenes* in cheese samples containing 0.02% cumin essential oil showed 1 log reduction after 30 days and goes to zero after that. Presence of 0.04% essential oils caused bacterial reduction up to 1 log after 15 days, that goes to zero and was not isolated after that, while in control samples (cheese without essential oil) bacteria were isolated during all periods.[56]
11	*Mentha spicata*	Lamiaceae	Spearmint	MICs of peppermint essential oil and nisin were determined to be 160 and 320 μL/mL, respectively.[57]
12	*Ziziphora clinopodioides*	Lamiaceae	*Thymus vulgaris*	MIC of *Thymus vulgaris* for growth of *Listeria monocytogenes* was 1 μL/mL.[58]
13	*Allium ascalonicum* *Pimpinella anisum*	Alliaceae Apiaceae	Shallot Anise	Results showed that shallot essential oil has highest antibacterial power against *Listeria monocytogenes*. Essential oil of anise showed good antibacterial effects on *Listeria monocytogenes*.[59]
14	*Parstinaca sativa* *Daucus carota*	Apiaceae Apiaceae	Parsnip Carrot	*Berberis volgaris* has been shown to be effective against bacteria in various doses, however, *Daucus carota* on some doses. The activity of *Parstinaca sativa*, but not *Daucus carota*, was changed after 1 hour of keeping in refrigerator. Both types of carrots had significant inhibitory effects on *Listeria monocytogenes* but effect of parsnip was far more than carrots.[60]

Abbreviations: MBC, minimum bactericidal concentration; MIC, minimum inhibitory concentration; PTCC, Persian type culture collection.

disorders,[20,21] hyperlipidemia and related diseases,[22-26] skin disorders,[27,28] pain,[29-32] parasitic and bacterial diseases,[33-40] respiratory diseases,[41] anxiety, stress, and neurological diseases,[42-44] and gastrointestinal diseases.[45,46]

Methods and Materials

Information of this review article was obtained by searching various keywords such as *Listeria monocytogenes*, medicinal plant, plant extracts, and essential oils among scientific articles published in

databases such as Google Scholar, ISI Web of Knowledge, PubMed, Scopus, SID, and Magiran of which only publications in English and Persian languages published between 1976 and March 2015 were searched. Overall, 45 articles were retrieved, out of which 14 articles were excluded for being irrelevant to research purposes.

Results

Effective medicinal plants against *Listeria monocytogenes* are listed in Table 1.

Discussion

Recently antimicrobial effects of medicinal plants and their secondary metabolites have been studied.[54,61] Chemical compositions of native medicinal plants in Iran that have positive antibacterial effects on *Listeria monocytogenes* have been reviewed in this study.

Carvacrol and thymol are the most prominent phenolic compounds with different levels in various parts of the thyme plant, including leaves, flowers, and roots. Thyme also contains tannins, flavonoids, saponins, and bitter substances.[54]

German chamomile flowers extract contain flavonoids and coumarin. Kamazolen presence in chamomile gives blue color to its essential oil. Because of the existence of flavonoids, flowers of chamomile have a moisturizing and fragrance effect and for this reason are widely used in cosmetic industry.[55,56] Camphor is the main chemical components of great chamomile essential oil.[57]

Onion, because it contains flavonoids and alkyl-cysteine sulfoxide, has an important role in human health and nutrition. Alkyl-cysteine sulfoxide is the main precursor of onion flavoring materials.[58]

Nutmeg essential oil contains borneol, geraniol, linalool, terpineol, eugenol, myristicin, and safrol.[59] Different parts of *Artemisia aucheri* plant comprise flavonoids, santonian, lipids, and bitter compounds.[60] Combinations of saffron Croatia, Christian, and crocin are picrocrocin.[62] Rosemary is a rich source of phenolic compounds with antimicrobial effects against positive and negative bacteria.[63]

Thymol, carvacrol, α- and β-pinene, parasimon compounds have been reported in ajowan essential oil.[64] Sabinene, flavonoids, polysaccharides, coumarin, cuminaldehyde, pinene, and terpinene are noted as the main components of the ajowan plant.[65]

Chemical composition of the peppermint essential oil contains carvone, limonene, 1,8-cineole, linalool, menthol, menthone, and isomenthone.[66-68]

Allium genus plants such as shallot, garlic, and onions are rich in flavonols and organosulfur components.[69,70]

Thymus vulgaris (*Ziziphora tenuior*) essential oil is composed of oxygen-containing monoterpene, pulegone, isomenthone, 1,8-cineole, and isopiperitone.[71]

Review of the obtained results of this study showed that bioactive phytochemicals, antioxidants and monoterpenes, sesquiterpene, coumarin, flavonoids, tannins, saponins, alkaloids, and terpenoids are the main ingredients of antilisteriosis medicinal plants. Derivation of these compounds and complementary pharmacological studies can demonstrate their use as impressive drugs against *Listeria monocytogenes* and other pathogen bacteria. The mechanism by which these plants act against *Listeria* is still not clear; however, phenolic components of plants have been attributed to their antimicrobial activities. If this is true, other plants having these compounds[72-82] should also possess antibacterial activity and beneficial effect against this pathogen, which will be worth examining. Due to the to be increased of prevalence of antibiotic resistance in the bacterial diseases in Iran,[83-86] identification of effective medicinal plants is necessary for finding natural active pharmaceutical ingredients for production of herbal antibiotics against the bacterial diseases. Should also possess antibacterial activity and beneficial effect against this pathogen, which will be worth examining.

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Author Contributions

All the authors wrote the first draft of the manuscript equally. MRK revised and edited the last version.

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